another way, as medicine becomes more scientific a more scientific approach to medical practice will be needed. In his paper, Sanazaro suggests three important points which are linked. The data base for a physician's practice performance is to be found in the patient care record, whether in office or hospital. Professional accountability, like fiscal accountability, depends upon adequate data and adequate records which can be reviewed and studied. Another point is that comparisons of practice data, whether among physicians, hospitals or regions may emerge as useful indicators of performance. And then he suggests (as he did at a recent California Medical Association conference) that some system of "performance assessment credits" be established to recognize and reward physicians who develop and study their own practice data and participate in objective measurement of their personal practice performance.

The idea of accountability for professional performance is one whose time has about come. It should be welcomed by all physicians in the interest of more scientific, more accountable and therefore better patient care.

—MSMW

Myocardial Perfusion Scintigraphy

ELSEWHERE IN THIS ISSUE, Dr. James McKillop presents an in-depth analysis of the history, technique and clinical applications of myocardial perfusion scintigraphy. As Dr. McKillop notes, perfusion scintigraphy using thallium 201 has been widely investigated and applied to the evaluation of clinical problems. When the main clinical question involves the diagnosis of coronary disease, stress perfusion scintigraphy followed by redistribution imaging has been shown by numerous studies to be more sensitive than stress electrocardiography, and probably more specific as well.[1] Although redistribution examination may lead to an overdiagnosis of infarction, this method presents a definite advantage over rest imaging in saving time and expense, and in reducing patients' exposure to radiation. If it is critical to establish the presence and extent of previous infarction in a patient without a history of such an event, but for whom abnormal results on redistribution imaging persist, a later rest image may be carried out for clarification.

Although stress perfusion scintigraphy frequently underestimates the degree of vascular involvement, it appears to be sensitive for the diagnosis of coronary disease in patients with triple-vessel involvement. It also complements stress electrocardiograms for identifying the high-risk lesions of triple-vessel and left main coronary artery disease.[2] However, it is important not to confuse the extent of coronary disease with the extent of stress-induced ischemia. While coronary angiography provides an anatomic measure of the extent of coronary vascular involvement, perfusion scintigraphy provides a physiological marker for the extent of ischemia and infarction.

Perfusion scintigraphy is a relative technique, providing a regional indication of blood flow in various areas of the myocardium, and does not provide an absolute marker of perfusion. There is no reason to believe that in patients with multiple-vessel coronary disease, stress-induced ischemia will develop in all myocardial regions at risk. More likely, ischemia will be manifest in the most underperfused region depending on the degree of narrowing of the supplying coronary vessel, modified by the effects of collateral perfusion and the level of stress achieved. These factors likely explain some of the discrepancies between the physiological findings on perfusion scintigraphy and the anatomic findings on angiography. Similarly, stress perfusion scintigraphy carried out in patients following coronary artery bypass graft operations does not simply reflect the state of graft patency, but the combination of graft status, the state of the native vasculature and the contribution of collaterals.[3]

As a noninvasive indicator of myocardial perfusion, thallium 201 scintigraphy provides clinicians with a unique tool to assess and monitor the pathological effect of anatomic coronary stenoses or other factors which may prejudice myocardial perfusion. It is not surprising, then, that transient coronary spasm may produce scintigraphic abnormalities. Likewise, in the hypertrophied myocardium of patients with tight aortic stenosis, ischemia can also develop in the presence of stress. Under these conditions a patient may have positive ECG and scintigraphic changes in the absence of narrowing of coronary vessels. However, such scintigraphic abnormalities should not be classified as false-positive results; they are likely related to true ischemic manifestations in the absence of coronary artery disease. A recent study[4] and several cases in our own experience

have documented localized stress-induced scintigraphic abnormalities in the setting of stress-induced ST segment elevation and transmural myocardial ischemia.

The physiological nature of the scintigraphic study permits its application, along with other such indicators of ischemia as stress electrocardiography and stress blood-pool scintigraphy, to the determination of the physiological significance of a coronary lesion visualized on angiography. While the advantages of stress perfusion scintigraphy over stress electrocardiography have been fairly well delineated, a comparative evaluation of the diagnostic sensitivity of perfusion scintigraphy and stress blood-pool scintigraphy is still under investigation. A scintigraphic functional evaluation appears to assess more thoroughly the degree of vascular involvement.[5] It also has special clinical applications as an aid for assessing the degree of functional impairment and for charting the course of therapy in patients with valvular heart disease.[6]

Although possessing a high degree of diagnostic accuracy and excellent specificity for recognizing coronary disease, stress perfusion scintigraphy lacks the level of sensitivity needed for making a judgment based only on negative test results. Therefore, the test is best used for patients with atypical pain; for those with equivocal stress test results in the presence of conduction abnormalities, ventricular hypertrophy, drug or electrolyte abnormalities; for those with borderline or ambiguous stess test results, or for any patient with a difficult or conflicting spectrum of diagnostic symptoms and signs of coronary disease. While scintigraphic findings in such cases cannot guarantee a correct diagnosis, they can help to clarify equivocal results, thereby pointing the way toward a correct diagnostic and future therapeutic course.[7] Scintigraphic results must not be accepted in a vacuum but must be evaluated in the light of associated clinical data. Scintigraphy often provides objective diagnostic information which is complementary to that of stress electrocardiography. In general, positive findings on a stress scintigram and stress electrocardiogram provide a higher degree of diagnostic certainty regarding the presence of coronary disease than does either test result alone; and negative stress scintigraphic and electrocardiographic results at optimal stress virtually exclude a diagnosis of coronary disease. Regardless of the findings on stress electrocardiography or stress scintigraphy, any decision to proceed with invasive diagnostic evaluation or medical treatment should depend on the entire spectrum of clinical data as derived from the history, physical examination and other test results.

To increase the diagnostic sensitivity of stress perfusion scintigraphy, a variety of computer enhancement methods have been devised. These methods have improved diagnostic sensitivity, at the expense of a somewhat reduced specificity.[8] Although such computer methods frequently provide increased overall accuracy and aid in quantitation of scintigraphic abnormalities, this loss of specificity should be kept in mind. Tomographic methods, also undergoing investigation, may also aid in diagnostic accuracy and quantitation of perfusion scintigraphic abnormalities.

While perfusion scintigraphic abnormalities at rest are relatively nonspecific and may indicate remote infarction, acute infarction or ongoing ischemia, the method can be useful in excluding a diagnosis of acute infarction if carried out soon after the onset of chest pain.[9] Furthermore, quantitation of such perfusion scintigraphic abnormalities has provided an extremely valuable prognostic index of the patient's condition shortly after acute infarction.[10] The variability in the size of such defects following the acute event shows promise as a marker of acute infarct size as well as of related, peri-infarction ischemia—important therapeutic and prognostic measurements for an accurate diagnosis of the patient's disorder. In addition, rest perfusion scintigraphy can be useful for the diagnosis of remote infarction, especially in the presence of a negative or ambiguous history or electrocardiogram.

Like other scintigraphic techniques used to evaluate the heart, perfusion scintigraphy, both at rest and with stress, requires a significant investment of personnel, equipment, time and effort.

These tests require a high degree of quality control and should be used only after due consideration, planning, and acquisition of the personnel and materials required to do a satisfactory job. The proper performance, interpretation and clinical application of perfusion scintigraphy and other nuclear cardiology studies should involve personnel trained in nuclear medicine, cardiology and, in some cases, computer science. The widespread clinical use of nuclear cardiology techniques, and the increasing availability of software packages, minicomputers, state of the art scintillation cameras and necessary radioactive pharmaceutical

agents, has prompted increased use of perfusion scintigraphy in nuclear medicine departments in university and community hospitals throughout the United States. However, judging from our own experience and from those of others at institutions, where perfusion scintigraphy and nuclear cardiology techniques have been firmly established as important clinical tools, the proper performance, analysis and clinical application of these methods best involves the combined, cooperative effort of nuclear medicine and cardiology personnel. It is only with the combined expertise of both disciplines that nuclear cardiology methods can achieve their optimal use and that clinical cardiologists and cardiac patients alike can reap the full benefits of perfusion scintigraphy and other developing methods of imaging.

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